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**Lee et al.**

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(54) **IMAGE FORMING APPARATUS AND CONTROL METHOD THEREOF**

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***G03G 21/00*** (2006.01)
***G03G 15/14*** (2006.01)

(52) **U.S. Cl.**
CPC ..... ***G03G 15/14*** (2013.01)

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See application file for complete search history.

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(74) *Attorney, Agent, or Firm* — Staas & Halsey LLP

(57) **ABSTRACT**

An image forming apparatus to control a distance between paper sheets by sensing a surface pattern of fed paper and a method of controlling the same is provided. The image forming apparatus may include a paper transport unit configured to transport paper, a paper sensing unit disposed in a transport path of the paper and configured to sense a surface pattern of the transported paper, and a controller configured to control the paper transport unit to adjust a distance between paper sheets based on a change in the sensed surface pattern of the paper.

**18 Claims, 19 Drawing Sheets**

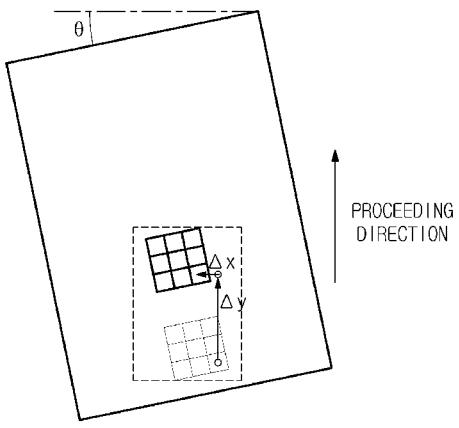


FIG. 1A

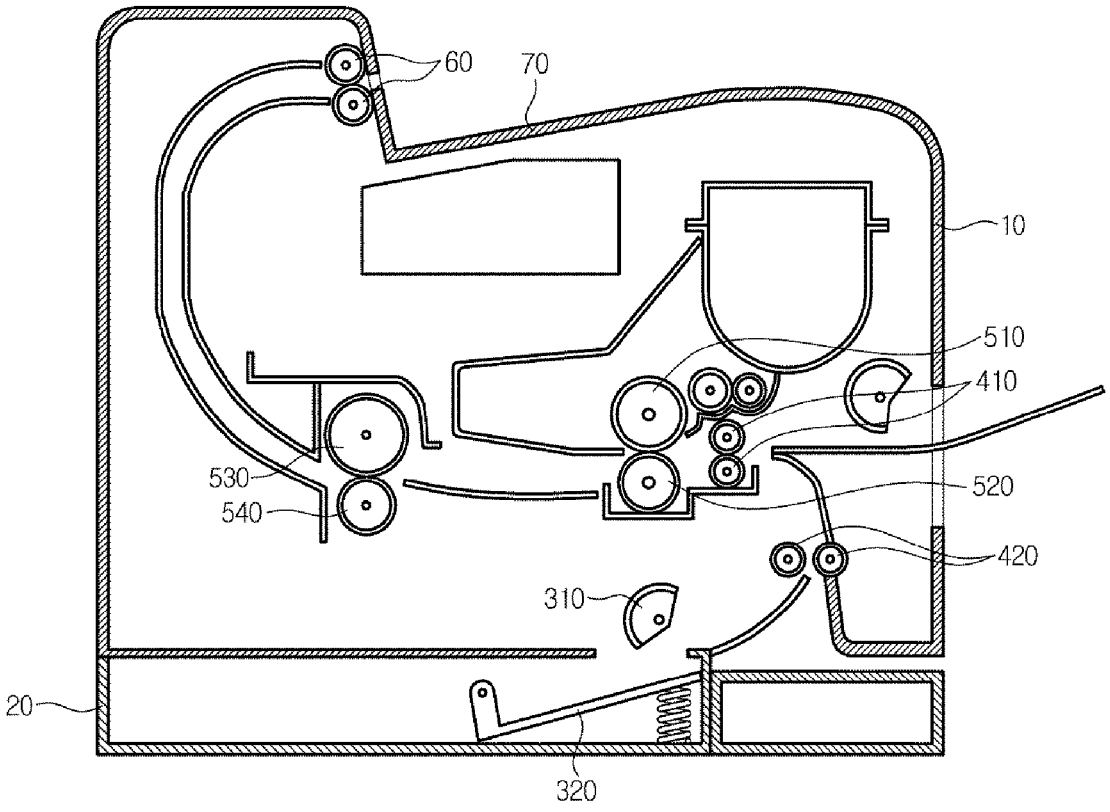


**FIG. 1B**

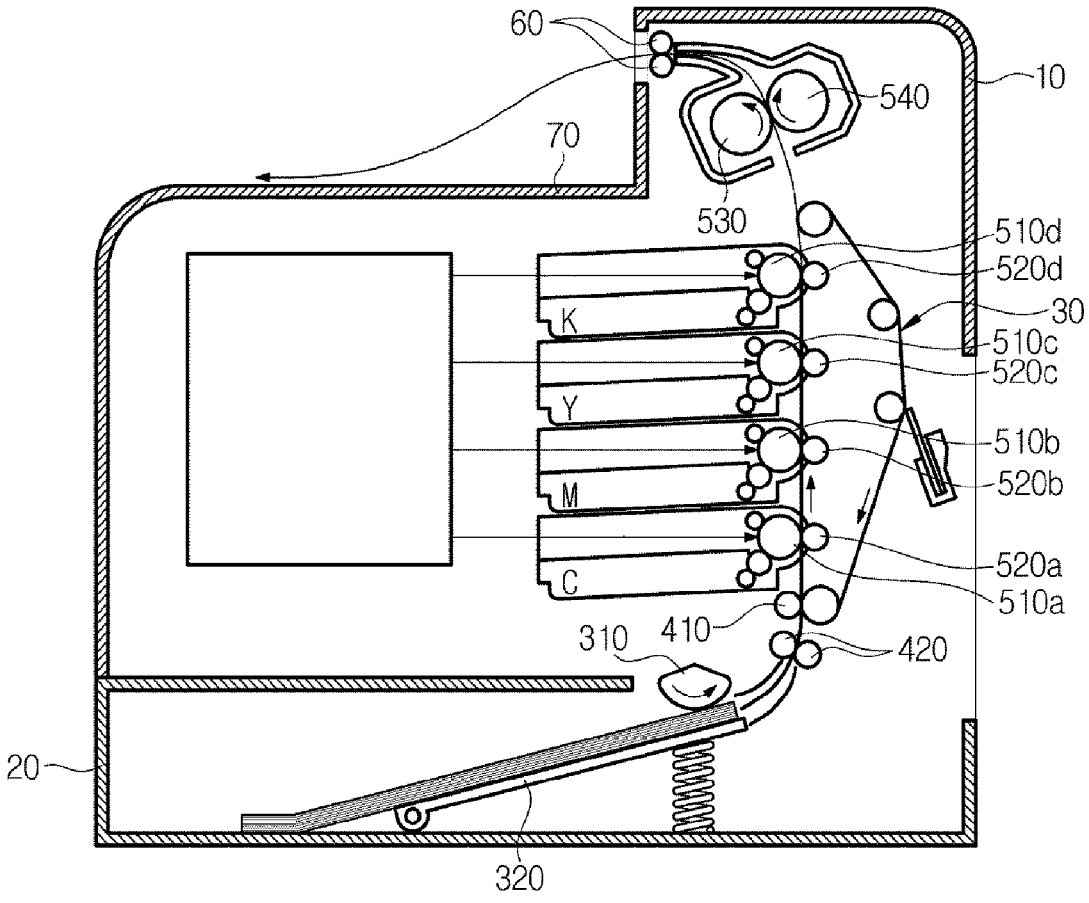

60
10
540
70
530
510d
520d
30
K
510c
520c
Y
510b
520b
M
520a
C
510a
310
410
420
20
320

**FIG. 2**

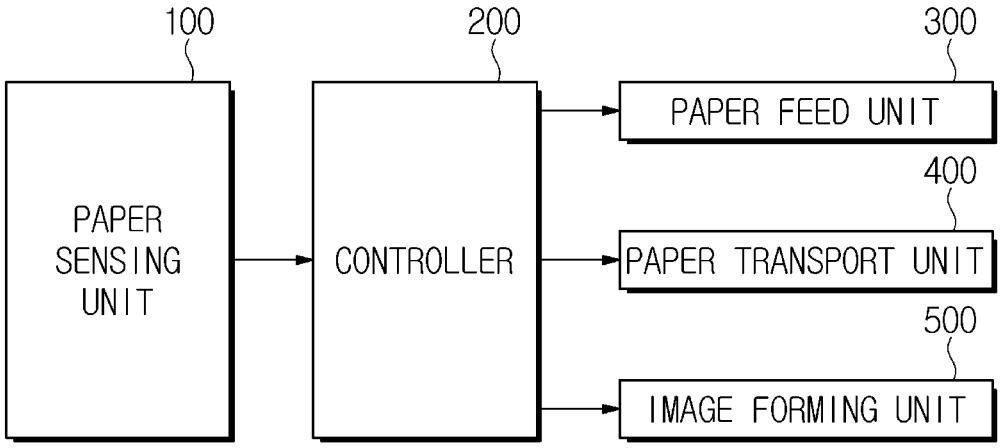

100
200
300
PAPER FEED UNIT
400
PAPER SENSING UNIT
CONTROLLER
PAPER TRANSPORT UNIT
500
IMAGE FORMING UNIT

**FIG. 3**

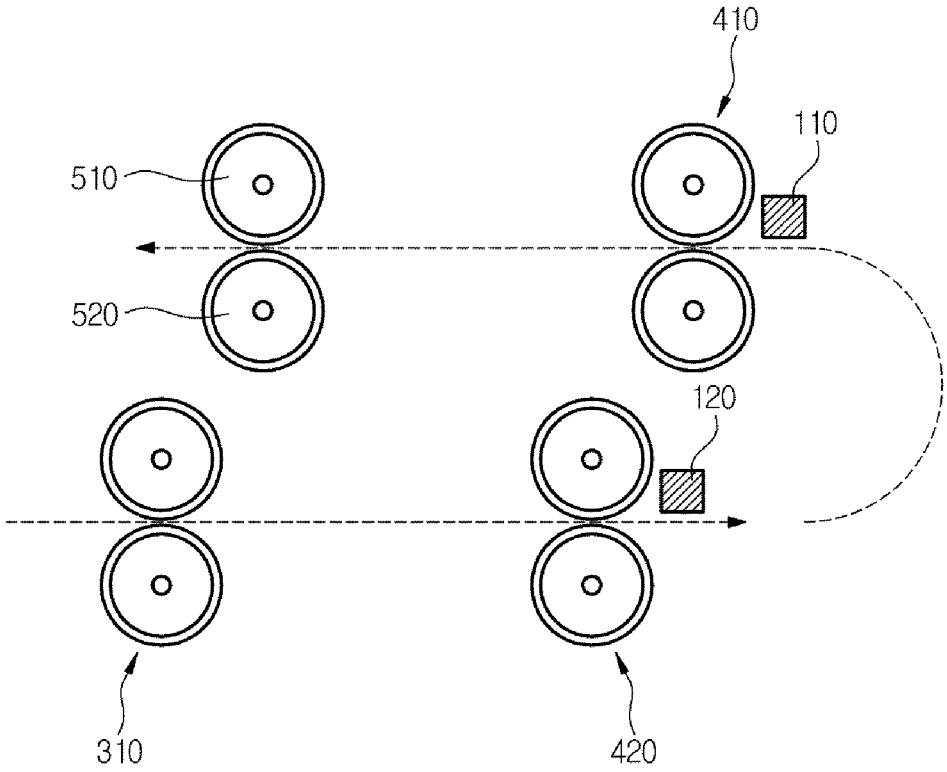


FIG. 4A

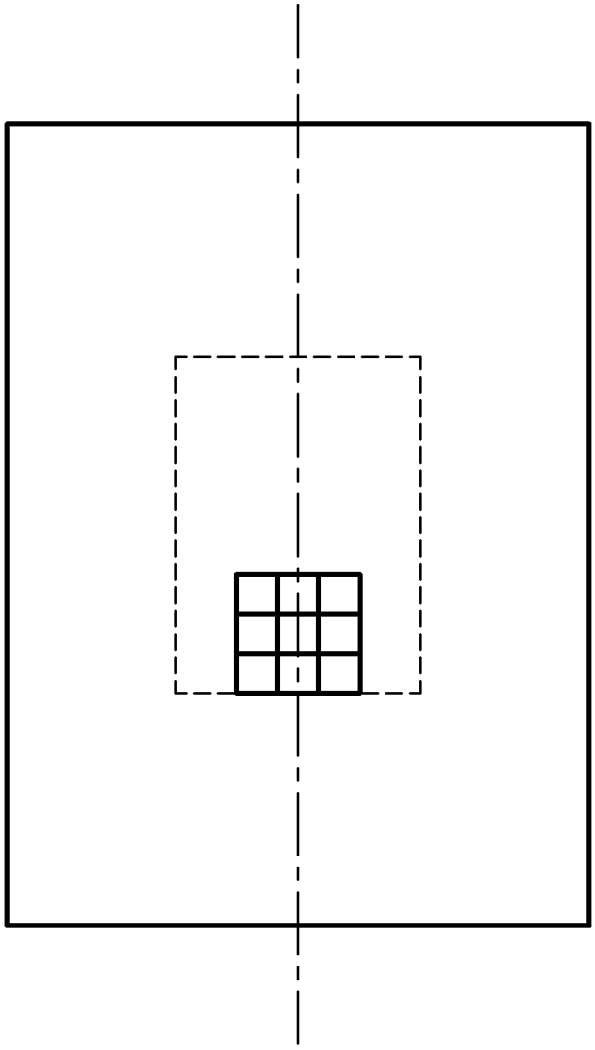


FIG. 4B

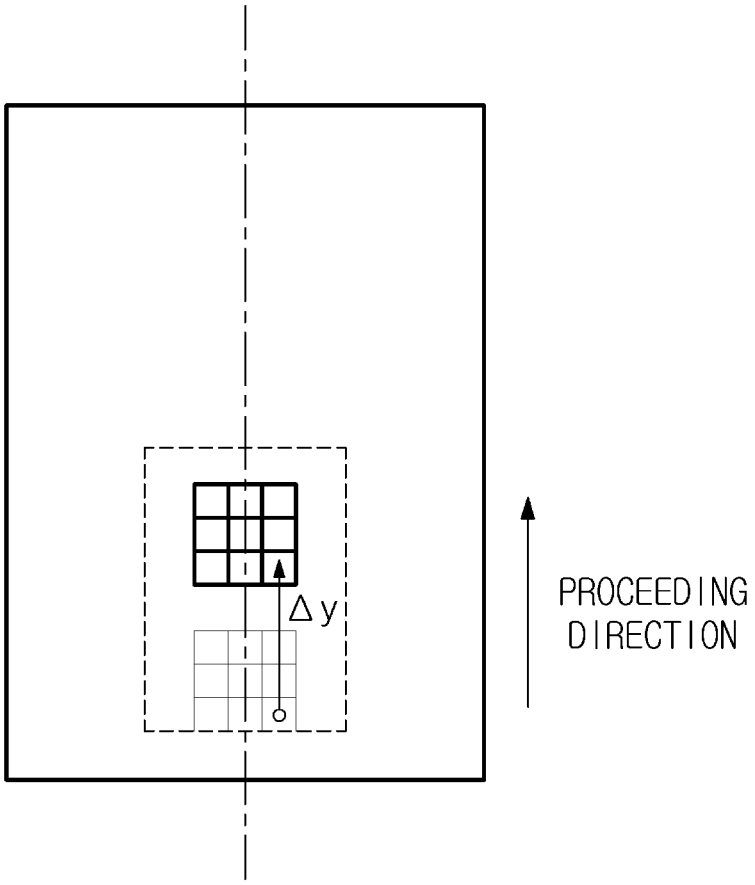


FIG. 5A

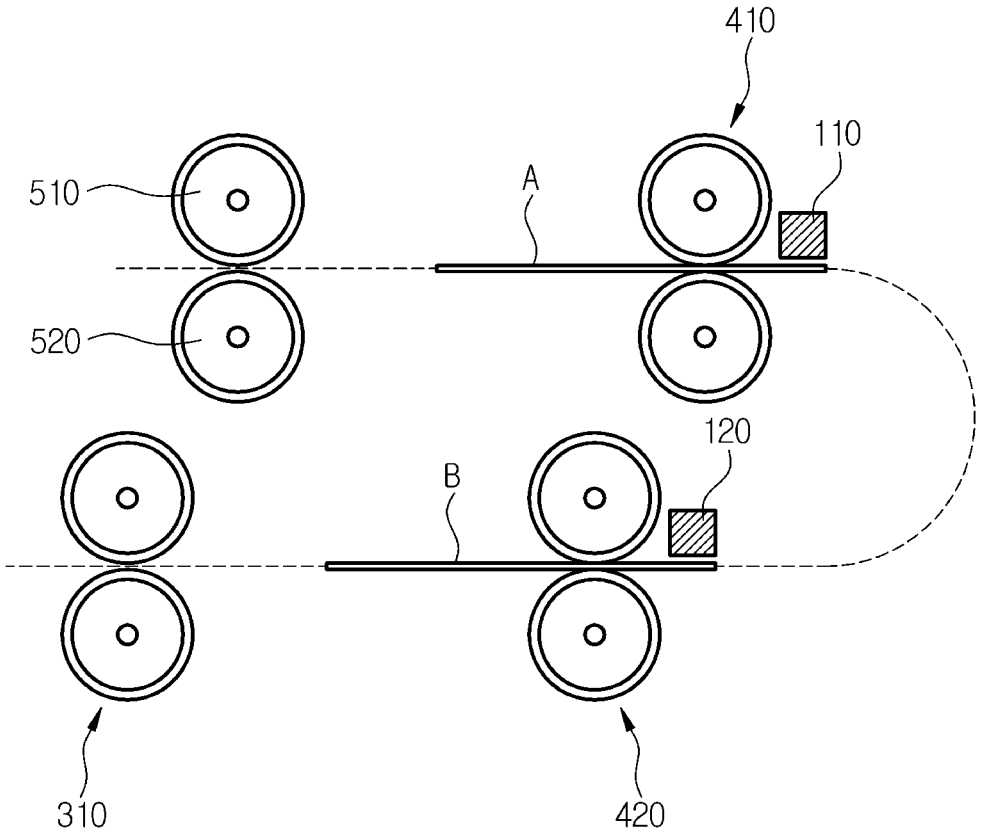


**FIG. 5B**

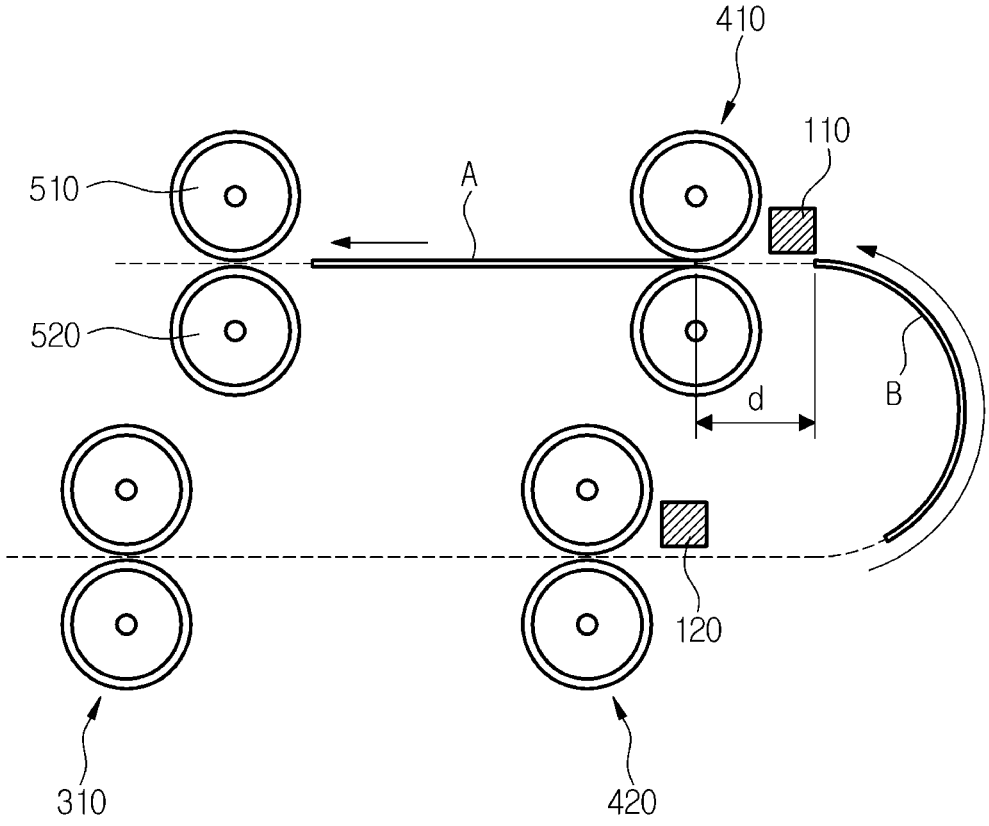


FIG. 6A

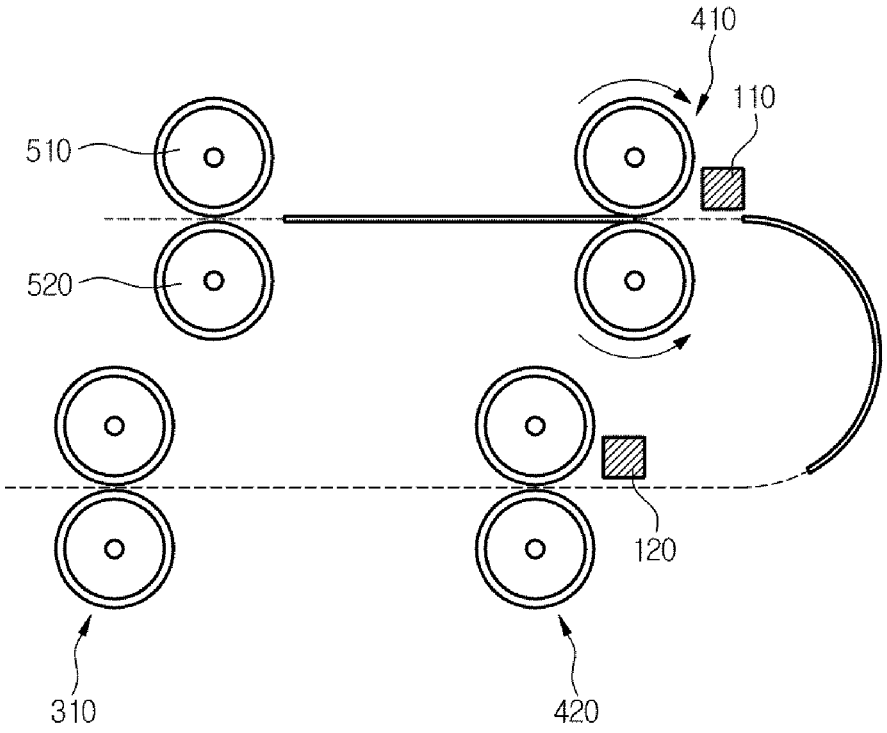


**FIG. 6B**

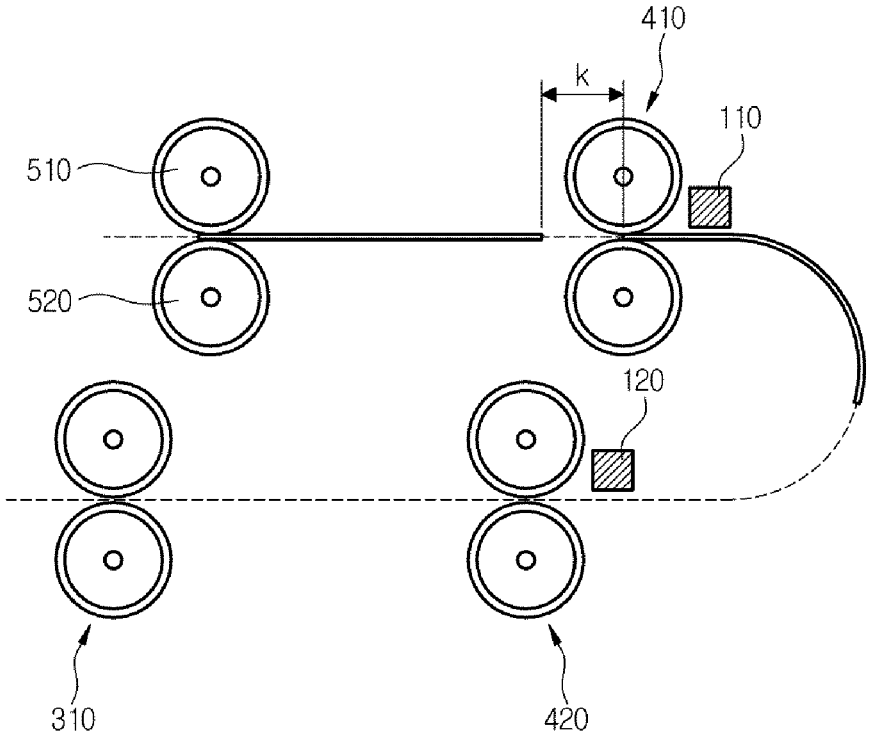


FIG. 7A

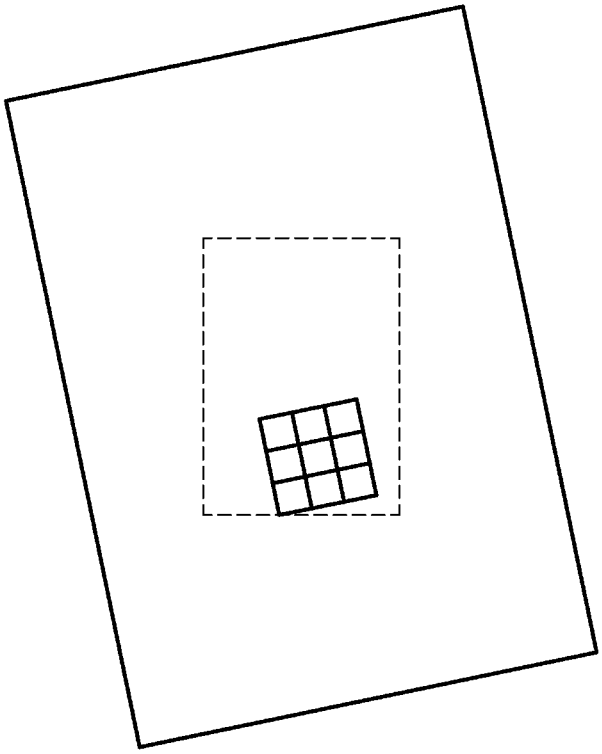


FIG. 7B

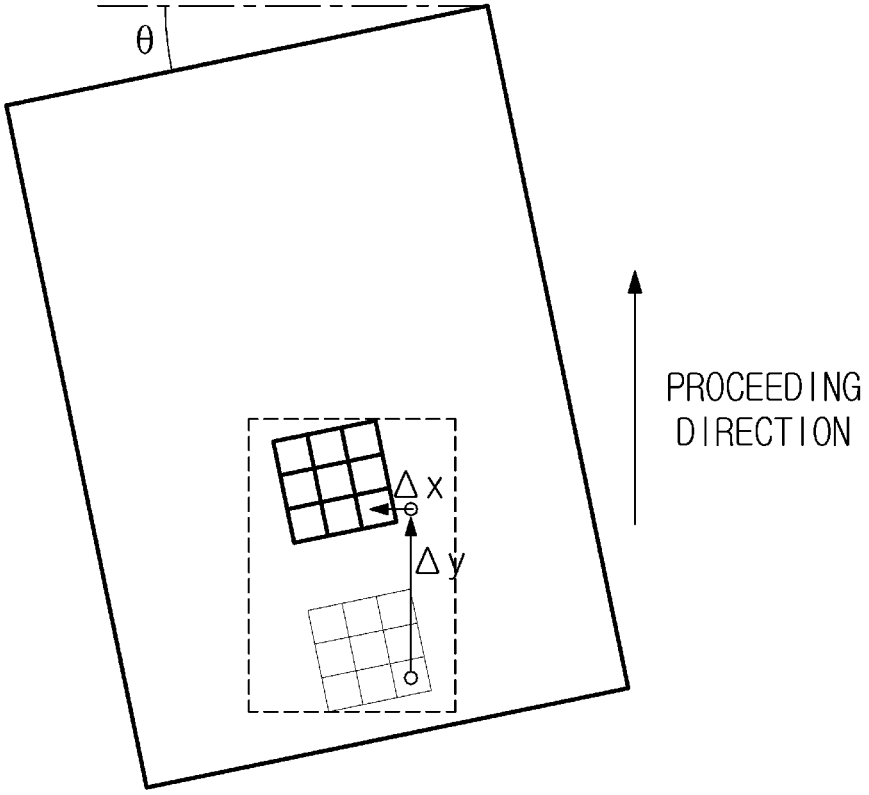


FIG. 8A

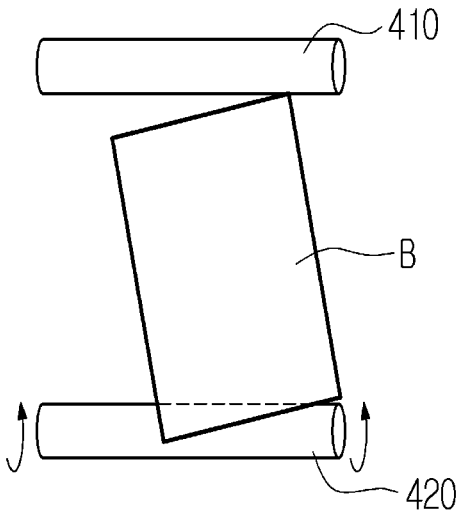


**FIG. 8B**

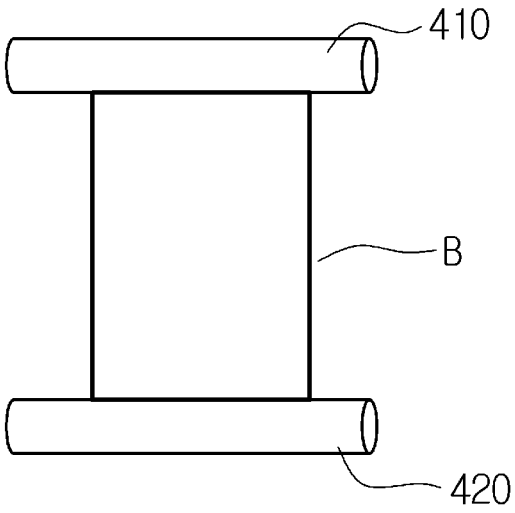


FIG. 8C

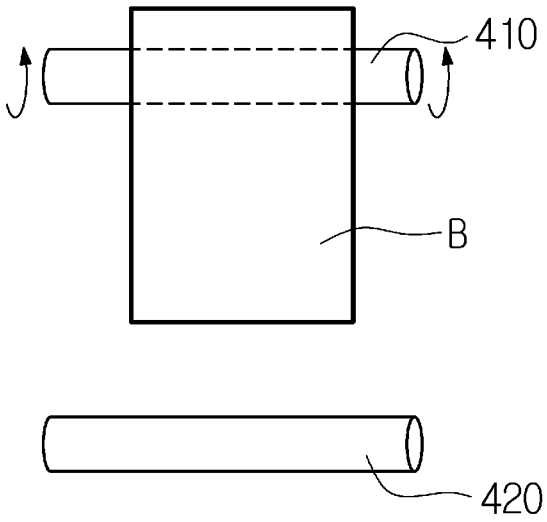


**FIG. 9**

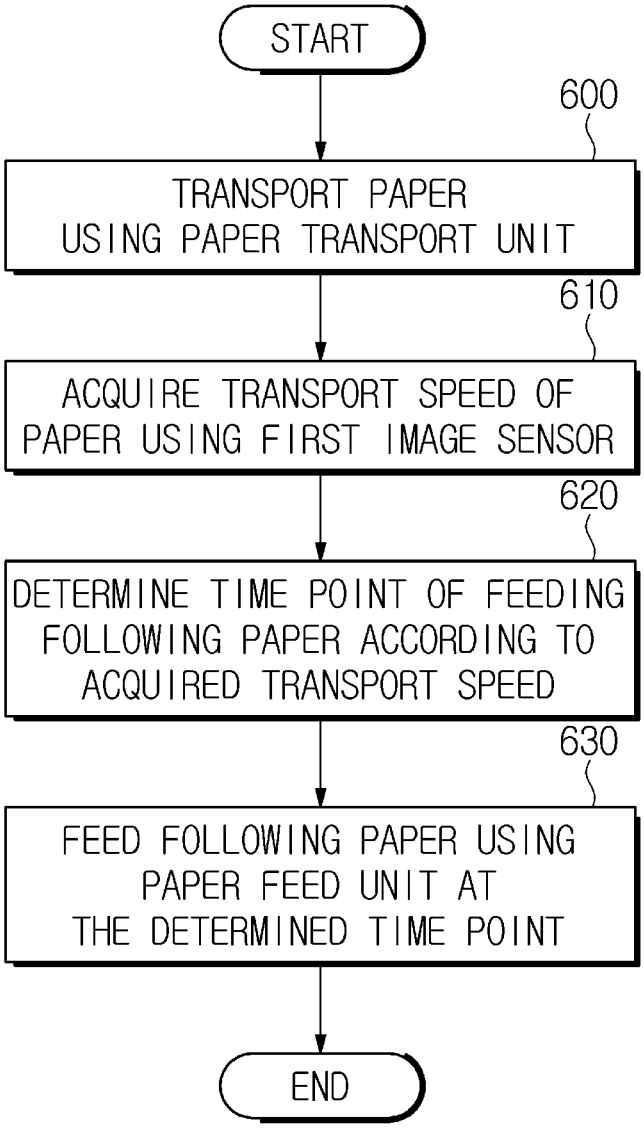

START
600
TRANSPORT PAPER USING PAPER TRANSPORT UNIT
610
ACQUIRE TRANSPORT SPEED OF PAPER USING FIRST IMAGE SENSOR
620
DETERMINE TIME POINT OF FEEDING FOLLOWING PAPER ACCORDING TO ACQUIRED TRANSPORT SPEED
630
FEED FOLLOWING PAPER USING PAPER FEED UNIT AT THE DETERMINED TIME POINT
END

**FIG. 10**

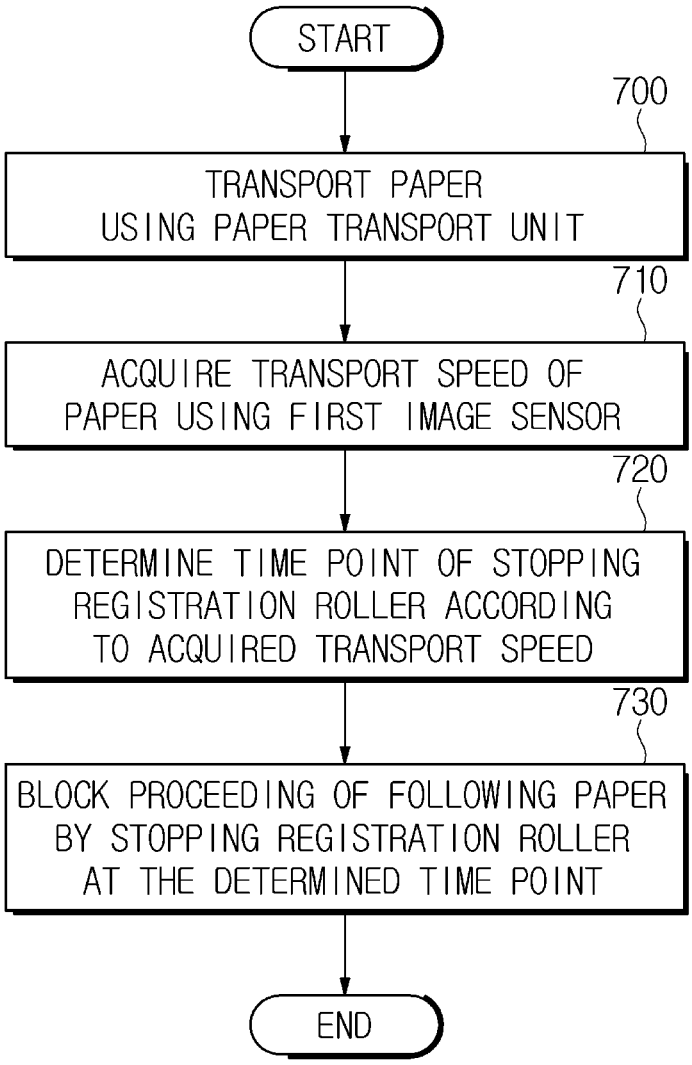

START
700
TRANSPORT PAPER USING PAPER TRANSPORT UNIT
710
ACQUIRE TRANSPORT SPEED OF PAPER USING FIRST IMAGE SENSOR
720
DETERMINE TIME POINT OF STOPPING REGISTRATION ROLLER ACCORDING TO ACQUIRED TRANSPORT SPEED
730
BLOCK PROCEEDING OF FOLLOWING PAPER BY STOPPING REGISTRATION ROLLER AT THE DETERMINED TIME POINT
END

**FIG. 11**

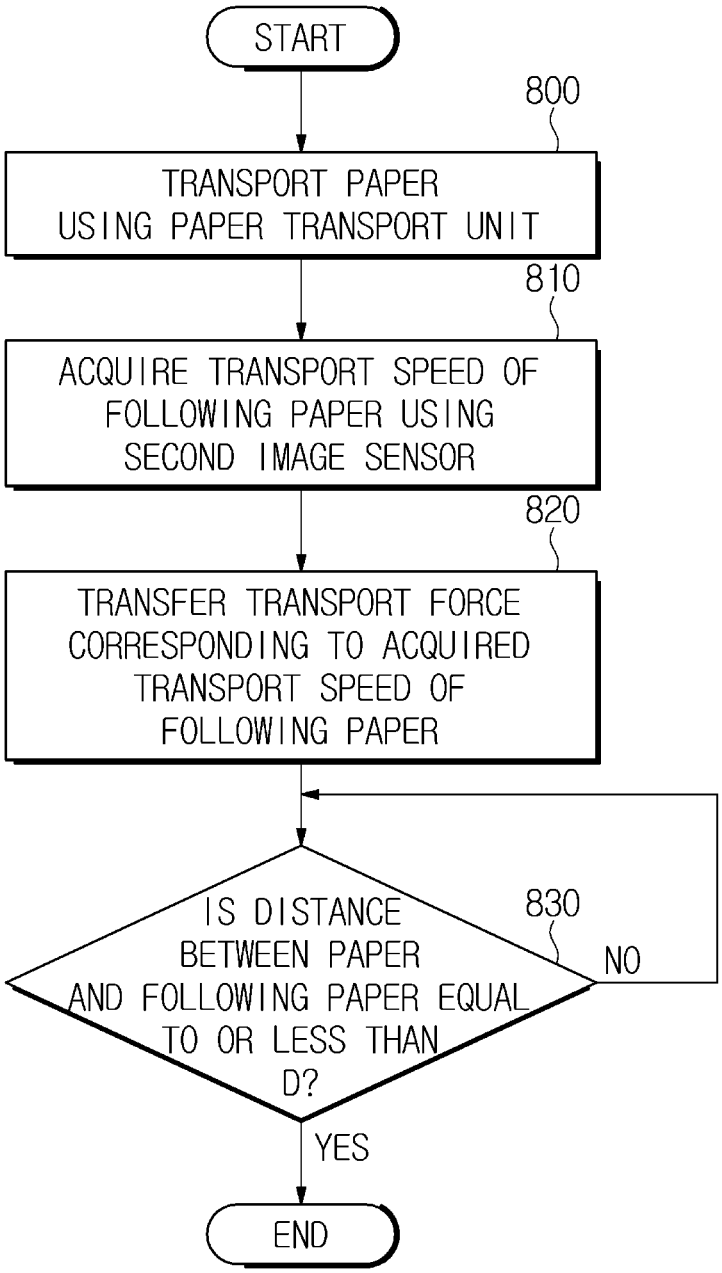
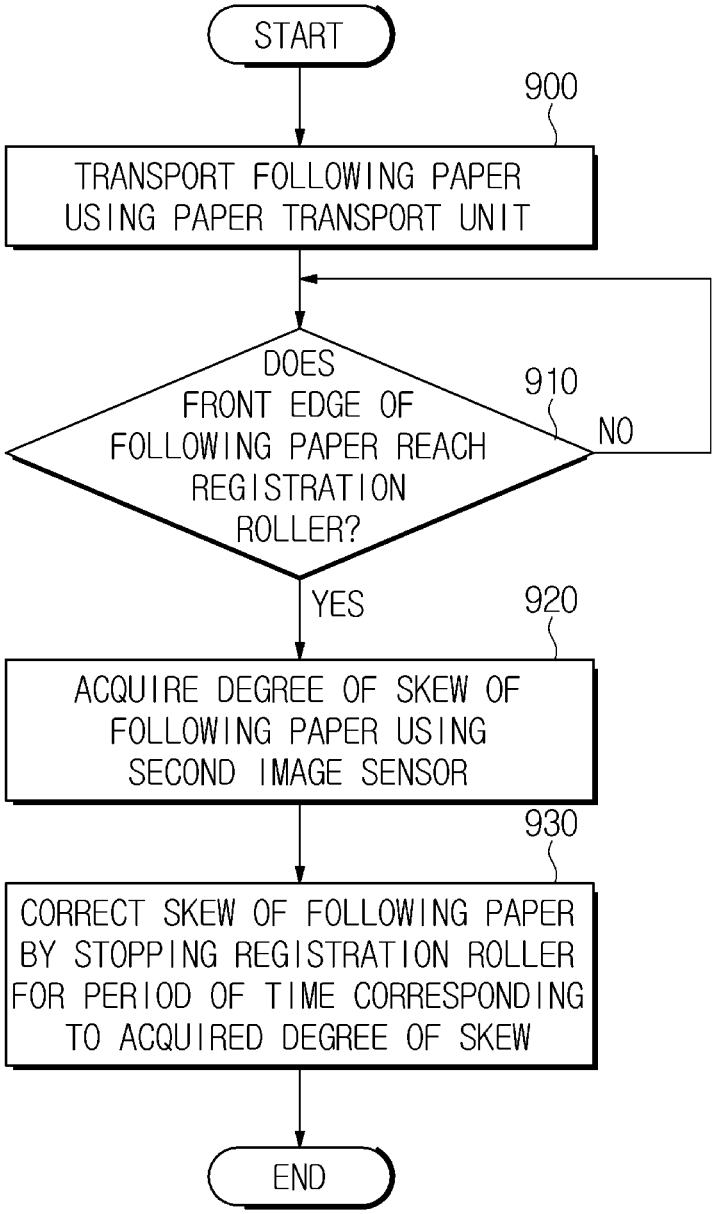

START
800
TRANSPORT PAPER USING PAPER TRANSPORT UNIT
810
ACQUIRE TRANSPORT SPEED OF FOLLOWING PAPER USING SECOND IMAGE SENSOR
820
TRANSFER TRANSPORT FORCE CORRESPONDING TO ACQUIRED TRANSPORT SPEED OF FOLLOWING PAPER
830
IS DISTANCE BETWEEN PAPER AND FOLLOWING PAPER EQUAL TO OR LESS THAN D?
NO
YES
END

**FIG. 12**


START
900
TRANSPORT FOLLOWING PAPER USING PAPER TRANSPORT UNIT
DOES FRONT EDGE OF FOLLOWING PAPER REACH REGISTRATION ROLLER?
910
NO
YES
920
ACQUIRE DEGREE OF SKEW OF FOLLOWING PAPER USING SECOND IMAGE SENSOR
930
CORRECT SKEW OF FOLLOWING PAPER BY STOPPING REGISTRATION ROLLER FOR PERIOD OF TIME CORRESPONDING TO ACQUIRED DEGREE OF SKEW
END

# IMAGE FORMING APPARATUS AND CONTROL METHOD THEREOF

## CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims the priority benefit of Korean Patent Application No. 10-2014-0070531, filed on Jun. 11, 2014 in the Korean Intellectual Property Office, the disclosure of which is incorporated herein by reference.

## BACKGROUND

1. Field

Embodiments of the present disclosure relate to an image forming apparatus that forms an image on a print medium and a method of controlling the same.

2. Description of the Related Art

An image forming apparatus is an apparatus capable of printing an image on a print medium such as printing paper. Examples of the image forming apparatus include printers, photocopiers, facsimiles, and multifunction printers having some or all of the functions of these devices.

Image forming apparatuses are classified into inkjet-type image forming apparatuses that print an image onto a print medium by jetting and ejecting fine ink droplets onto a desired region of the print medium and electrophotographic image forming apparatuses that print an image by supplying toner to a latent image formed by scanning light beams onto a photosensitive drum and transferring the latent image onto a print medium.

An image forming apparatus may form an image by receiving paper stacked in a paper cassette and transporting the received paper. In this regard, since printing speed and quality may be determined in accordance with a distance between paper sheets, the image forming apparatus may include a unit of controlling the distance between the paper sheets.

## SUMMARY

Therefore, it is an aspect of the present disclosure to provide an image forming apparatus controlling a distance between paper sheets by sensing surface patterns of the paper sheets fed to the image forming apparatus and a method of controlling the same.

In accordance with an aspect of the present disclosure, an image forming apparatus includes a paper transport unit configured to transport paper, a paper sensing unit disposed in a transport path of the paper and configured to sense a surface pattern of the transported paper, and a controller configured to control the paper transport unit to adjust a distance between paper sheets based on a change in the sensed surface pattern of the paper.

The controller may acquire a transport speed of the paper by using the change in the surface pattern of the paper and control the paper transport unit to maintain a predetermined paper sheet interval by using the acquired transport speed of the paper.

The controller may acquire a degree of skew of the paper by using the change in the surface pattern of the paper and control the paper transport unit to correct the skew of the paper for a period of time corresponding to the acquired degree of skew of the paper.

The paper transport unit may include feed rollers configured to transfer a transport force to the paper, and registration rollers configured to block proceeding of the paper to which the transport force is transferred by the feed rollers, and the paper sensing unit may be disposed in the transport path of the paper between the feed rollers and the registration rollers.



The paper sensing unit may include a first image sensor disposed closer to the registration rollers than the feed rollers to sense a surface pattern of a paper transported before following paper.

The controller may acquire a transport speed of the paper by using a change in the surface pattern of the paper sensed by the first image sensor and control the registration rollers to block proceeding of the following paper at a time point corresponding to the transport speed of the paper.

The image forming apparatus may further include a paper feed unit configured to sequentially feed the paper and the following paper to the paper transport unit, and the controller may acquire a transport speed of the paper by using a change in the surface pattern of the paper sensed by the first image sensor and control the paper feed unit to feed the following paper at a time point corresponding to the transport speed of the paper.

The paper sensing unit may include a second image sensor disposed closer to the feed rollers than the registration rollers to sense a surface pattern of the following paper transported after the paper.

The controller may acquire a transport speed of the following paper by using a change in the surface pattern of the following paper sensed by the second image sensor and control the feed rollers to transfer a transport force corresponding to the transport speed to the following paper.

The controller may acquire a degree of skew of the following paper by using a change in the surface pattern of the following paper sensed by the second image sensor and control the registration rollers to block proceeding of the following paper for a period of time corresponding to the degree of skew.

The image forming apparatus may further include an image forming unit configured to transfer an image to the paper by using a photosensitive drum on which toner is coated, and the controller may control the image forming unit to coat the toner on the photosensitive drum at a time point corresponding to when the registration rollers resume the proceeding of the paper.

In accordance with an aspect of the present disclosure, a method of controlling an image forming apparatus sequentially transporting a plurality sheets of paper includes sensing a surface pattern of the transported paper, and controlling a distance between the paper sheets based on a change in the sensed surface pattern.

The controlling of the distance between the paper sheets may include acquiring a transport speed of the paper by using a change in the surface pattern of the paper, and transporting the paper while maintaining a predetermined distance between the paper sheets by using the acquired transport speed.

The acquiring of the transport speed of the paper may include acquiring a transport speed of paper by using a change in a surface pattern of the paper transported before following paper.

The transporting of the paper while maintaining the predetermined distance between the paper sheets may include blocking proceeding of the following paper at a time point corresponding to the transport speed of the paper.

The transporting of the paper while maintaining the predetermined distance between the paper sheets may include feeding the following paper to a paper transport unit of the image forming apparatus at a time point corresponding to the transport speed of the paper.

The acquiring of the transport speed of the paper may include acquiring a transport speed of the following paper by using a change in a surface pattern of the following paper transported after the paper.

The transporting of the paper while maintaining the predetermined distance between the paper sheets may include transferring a transport force corresponding to the transport speed of the following paper to the following paper.

The method may further include acquiring a degree of skew of the paper by using the change in the surface pattern of the paper, and correcting the skew of the paper for a period of time corresponding to the acquired degree of skew.

The acquiring of the degree of skew of the paper may include acquiring a degree of skew of the paper when a front edge of the paper reaches registration rollers of the image forming apparatus.

The correcting of the skew of the paper may include blocking proceeding of the paper for a period of time corresponding to the degree of skew.

The method may further include coating toner on a photosensitive drum of the image forming apparatus at a time point corresponding to when the blocked proceeding of the paper is resumed.

In accordance with an aspect of the present disclosure, an image forming apparatus includes a paper transport unit configured to transport paper, and a controller configured to control the paper transport unit to adjust a distance between paper sheets based on a transport speed of the paper.

The paper transport unit may include feed rollers configured to transfer a transport force to the paper, and registration rollers configured to block proceeding of the paper to which the transport force is transferred by the feed rollers, and the controller may acquire a transport speed of paper transported before following paper.

The controller may control the registration rollers to block proceeding of the following paper at a time point corresponding to the transport speed of the paper.

The image forming apparatus may include a paper feed unit configured to sequentially feed the paper and the following paper to the paper transport unit, and the controller may control the paper feed unit to feed the following paper at a time point corresponding to the transport speed of the paper.

The paper transport unit may include feed rollers configured to transfer a transport force to the paper, and registration rollers configured to block proceeding of the paper to which the transport force is transferred by the feed rollers, and the controller may acquire a transport speed of the following paper transported after the paper.

The controller may control the feed rollers to transfer a transport force corresponding to the transport speed of the following paper to the following paper.

## BRIEF DESCRIPTION OF THE DRAWINGS

These and/or other aspects of the disclosure will become apparent and more readily appreciated from the following description of embodiments, taken in conjunction with the accompanying drawings of which:

FIGS. **1**A and **1**B are schematic cross-sectional views illustrating image forming apparatuses according to an embodiment of the present disclosure;

FIG. **2** is a control block diagram illustrating an image forming apparatus according to an embodiment of the present disclosure;

FIG. **3** is a diagram for describing a position of a paper sensing unit of an image forming apparatus according to an embodiment of the present disclosure;

FIGS. **4**A and **4**B are diagrams for describing a method of acquiring a transport speed of paper by a controller of an image forming apparatus according to an embodiment of the present disclosure;

FIGS. **5**A and **5**B are diagrams for describing a method of controlling a paper sheet interval by a controller of an image forming apparatus according to an embodiment of the present disclosure;

FIGS. **6**A and **6**B are diagrams for describing a method of controlling a paper sheet interval by a controller of an image forming apparatus according to an embodiment of the present disclosure;

FIGS. **7**A and **7**B are diagrams for describing a method of acquiring the degree of skew of paper by a controller of an image forming apparatus according to an embodiment of the present disclosure;

FIGS. **8**A to **8**C are diagrams for describing a method of controlling a skew of paper by a controller of an image forming apparatus according to an embodiment of the present disclosure;

FIG. **9** is a flowchart illustrating a method of controlling a paper sheet interval according to a method of controlling an image forming apparatus according to an embodiment of the present disclosure;

FIG. **10** is a flowchart illustrating a method of controlling a paper sheet interval according to a method of controlling an image forming apparatus according to an embodiment of the present disclosure;

FIG. **11** is a flowchart illustrating a method of controlling a paper sheet interval according to a method of controlling an image forming apparatus according to an embodiment of the present disclosure; and

FIG. **12** is a flowchart illustrating a method of correcting a skew of paper according to a method of controlling an image forming apparatus according to an embodiment of the present disclosure.

## DETAILED DESCRIPTION

Reference will now be made in detail to embodiments of the present disclosure, examples of which are illustrated in the accompanying drawings, wherein like reference numerals refer to like elements throughout.

An image forming apparatus and a method of controlling the same will be described in detail with reference to the drawings.

FIGS. **1**A and **1**B are schematic cross-sectional views of image forming apparatuses according to various embodiments of the present disclosure. FIG. **1**A illustrates a monotype image forming apparatus and FIG. **1**B illustrates a color-type image forming apparatus.

Referring to FIG. **1**A, the image forming apparatus includes: a case **10** defining an external appearance; a paper cassette **20** configured to stack a plurality of sheets of paper for printing and disposed at a lower portion of the case **10**; a paper feed unit **300** configured to feed the paper stacked in the paper cassette to a paper transport unit (paper transporter) **400**; the paper transport unit **400** configured to transport the fed paper; an image forming unit **500** configured to form an image on the paper transported by the paper transport unit **400**; a paper discharge roller **60** configured to discharge the paper on which the image is formed; and a paper discharge tray **70** in which the discharged paper is located.

The paper feed unit **300** may include a knock-up plate **320** to raise the paper stacked in the paper cassette upward and a pick-up roller **310** to feed paper supported by the knock-up plate to the paper transport unit **400**.

The paper feed unit **300** may select one of the plurality of sheets of paper at a time by using the knock-up plate **320** and the pick-up roller **310**. The paper feed unit **300** feeds the selected paper to the paper transport unit **400** to perform printing.

The paper transport unit **400** may include feed rollers **420** to transfer a transport force to the paper and registration rollers **410** to block proceeding of the paper to which the transport force is transferred by the feed rollers **420**.

The feed rollers **420** may rotate in one direction by a driving force received from a motor. The feed rollers **420** may contact surfaces of the fed paper and transfer the transport force to the paper via friction formed at the contact surfaces.

The registration rollers **410** may also rotate in one direction by a driving force received from the motor. The registration rollers **410** may transport the paper while contacting the paper to which the transport force is transferred. Furthermore, the registration rollers **410** may block the proceeding of the paper by stopping rotation in accordance with a control by a controller. This will be described later.

The image forming unit **500** may form an image on the paper received from the paper transport unit **400**. To this end, the image forming unit **500** may include a photosensitive drum **510**, a transfer roller **520**, a fusing roller **530**, and a pressing roller **540**.

A latent image may be formed on the surface of the photosensitive drum **510**. In this regard, the latent image may be formed by processing print data received from a host such as a computer. After the latent image is formed, toner may be uniformly coated on the surface of the photosensitive drum **510**. As a result, the image forming unit **500** is in a state capable of forming an image on the paper.

When the image forming unit **500** is ready for printing and the paper is transported from the paper transport unit **400**, the photosensitive drum **510** and the transfer roller **520** may attach the toner to the surface of the paper. That is, the paper may pass between the photosensitive drum **510** and the transfer roller **520**. As a result, toner may be attached to the surface of the paper in a shape of the image to be printed.

The fusing roller **530** and the pressing roller **540** may fuse the toner attached to the surface of the paper. The surface of the fusing roller **530** may be heated at a high temperature. The pressing roller **540** may be disposed under the fusing roller **530** and contact the fusing roller **530** while applying a strong pressure thereto. The paper to which the toner is attached may pass between the fusing roller **530** and the pressing roller **540**. In this process, the toner attached to the paper may be exposed to a high-temperature and high-pressure environment. As a result, the toner is melted and fused to the surface of the paper, thereby forming an image.

The paper on which the image is formed by the fusing process may be discharged to the paper discharge tray **70** by the paper discharge roller **60**.

Referring to FIG. **1**B, the color type image forming apparatus may also include the same constituent elements as the mono-type image forming apparatus. Since constituent elements of the color-type image forming apparatus are the same as those of the mono-type image forming apparatus, detailed descriptions thereof will not be given herein.

In addition, the color-type image forming apparatus may include a plurality of photosensitive drums **510***a*, **510***b*, **510***c*, and **510***d* on which cyan, magenta, yellow, and black toners are respectively coated and a plurality of transfer rollers **520***a*, **520***b*, **520***c*, and **520***d* corresponding thereto. The color-type image forming apparatus may further include a transfer belt **30** to assist the paper to which the transport force is transferred by the feed rollers **420** to pass between the plurality of photosensitive drums **510***a*, **510***b*, **510***c*, and **510***d* and the plurality of transfer rollers **520***a*, **520***b*, **520***c*, and **520***d*.

When a plurality of sheets of paper are sequentially fed for printing, an interval between paper sheets is referred to as a paper sheet interval. As high-speed printing has come into widespread use, it is becoming increasingly important to control the paper sheet interval in accordance with a proceeding speed of paper. Thus, according to an embodiment, an image forming apparatus capable of sensing a pattern change of paper and controlling the paper sheet interval based on the pattern change may be provided.

FIG. **2** is a control block diagram illustrating an image forming apparatus according to an embodiment of the present disclosure.

According to an embodiment, the image forming apparatus may further include: a paper transport unit **400** configured to transport paper; a paper sensing unit (paper sensor) **100** disposed in a paper transport path and configured to sense a surface pattern of the transported paper; and a controller **200** configured to control the paper transport unit **400** such that a distance between paper sheets based on a change in the sensed surface pattern change of the paper.

In addition, the image forming apparatus may further include: a paper feed unit **300** configured to sequentially feed the plurality of sheets of paper to the paper transport unit **400**; and an image forming unit **500** configured to transfer an image to the paper by using a photosensitive drum **510** on which toner is coated.

The paper transport unit **400**, the paper feed unit **300**, and the image forming unit **500** are the same as those described above with reference to FIG. **1**, and thus detailed descriptions thereof will not be given herein. However, a method of controlling the paper transport unit **400**, the paper feed unit **300**, and the image forming unit **500** will be described later with reference to the controller **200**.

The paper sensing unit **100** may be disposed in the paper transport path and may sense the pattern of paper in real time. To this end, the paper sensing unit **100** may sense the pattern of paper formed in a predetermined region at regular time intervals. Since the paper proceeds along the paper transport path by the paper transport unit **400**, the controller **200**, which will be described later, may acquire a transport speed of the paper by using a pattern change of the paper sensed by the paper sensing unit **100** at regular time intervals. The acquired transport speed of the paper may be used to control the paper sheet interval.

The paper sensing unit **100** may be disposed in the paper transport path between the feed rollers **420** and the registration rollers **410** of the paper transport unit **400**. Particularly, the paper sensing unit **100** may include: a first image sensor **110** disposed to be closer to the registration rollers **410** than the feed rollers **420** to sense a surface pattern of paper that is transported before following paper; and a second image sensor **120** disposed to be closer to the feed rollers **420** than the registration rollers **410** to sense a surface pattern of the following paper that is transported after the paper.

FIG. **3** is a diagram for describing a position of a paper sensing unit **100** of an image forming apparatus according to an embodiment of the present disclosure. Dashed lines indicate a paper transport path, and arrows indicate a paper transport direction.

As described above, the paper fed by the pick-up roller **310** of the paper feed unit **300** may be transported along the paper transport path by the feed rollers **420** of the paper transport unit **400**. The registration rollers **410** may control transporting of the paper proceeding along the paper transport path, and an image may be formed on the paper discharged from the

registration rollers **410** while passing between the photosensitive drum **510** and the transfer roller **520**.

The first image sensor **110** of the paper sensing unit **100** may be disposed adjacent to the registration rollers **410** to sense the surface pattern of the paper immediately before the paper passes between the registration rollers **410**. Accordingly, the first image sensor **110** may sense the surface pattern of the paper when the paper passes between the registration rollers **410**.

In addition, the second image sensor **120** of the paper sensing unit **100** may be disposed adjacent to the feed rollers **420** to sense the surface pattern of the paper immediately after the paper passes between the feed rollers **420**. Accordingly, the second image sensor **120** may sense the surface pattern of the following paper when the paper passes between the feed rollers **420**.

The first image sensor **110** and the second image sensor **120** of the paper sensing unit **100** may emit light to a predetermined region and receive reflected light in order to sense the surface pattern of the paper. Since light reflected by the surface of the paper includes information regarding the surface pattern of the paper, the paper sensing unit **100** may sense the surface pattern of the paper by receiving light reflected by the surface of the paper.

To this end, the first image sensor **110** and second image sensor **120** may respectively include a light emitting unit and a light receiving unit. The light emitting unit may be implemented using a light emitting diode (LED) and may emit light to the paper, and the light receiving unit may receive light reflected by the paper. The light receiving light may acquire information regarding the surface pattern of the paper based on the received light. The light receiving unit may be implemented using a complementary metal-oxide semiconductor (CMOS) or a charge-coupled device (CCD) and may also be implemented in various manners to sense a surface pattern of paper by receiving reflected light within the scope of the present disclosure.

Referring back to FIG. **2**, the controller **200** may control the paper sheet interval by using the surface pattern of paper sensed by the paper sensing unit **100**. Particularly, the controller **200** may acquire the transport speed by comparing surface patterns of paper acquired at regular time intervals and using the degree of change in the surface patterns.

FIGS. **4**A and **4**B are diagrams for describing a method of acquiring a transport speed of paper by a controller of an image forming apparatus according to an embodiment of the present disclosure. Regions marked by dashed lines may be regions including surface patterns of the paper sensed by the paper sensing unit **100**.

As described above, the paper sensing unit **100** may sense the surface patterns of paper at regular time intervals. For example, as illustrated in FIG. **4**A, the paper sensing unit **100** may sense the surface pattern within the region marked by the dashed line. After one period T, the paper sensing unit **100** may sense the surface pattern in the dashed line as illustrated in FIG. **4**B. Upon comparison between the sensed surface pattern of the paper of FIG. **4**A with the sensed surface pattern of the paper of FIG. **4**B, it may be confirmed that the paper is transported by Δy in the proceeding direction.

The controller **200** may acquire the transport speed of the paper based thereon. Particularly, the controller **200** may acquire the transport speed of the paper by using Equation 1.

$$V = \frac{\Delta y}{T} \qquad \text{Equation 1}$$

In Equation 1, V is a transport speed, T is a period in which the paper sensing unit **100** acquires the surface pattern of the paper, and Δy is a distance of paper transported during one period.

The controller **200** may control the paper transport unit **400** or the paper feed unit **300** such that a predetermined interval is maintained between paper sheets by using the acquired transport speed. In this regard, the predetermined interval may be an optimal paper sheet interval for high-speed printing and may be preset during a manufacturing process or may be predetermined by computation of a device. Alternatively, the interval may be predetermined by a desired paper sheet interval input by a user.

A method of controlling the paper sheet interval by the controller will be described with reference to FIGS. **5**A, **5**B, **6**A, and **6**B.

FIGS. **5**A and **5**B are diagrams for describing a method of controlling a paper sheet interval by a controller of an image forming apparatus according to an embodiment of the present disclosure. Dashed lines indicate a paper transport path, and arrows indicate a paper transport direction.

FIG. **5**A illustrates that paper passes between the registration rollers **410** and following paper passes between the feed rollers **420**.

When one leading edge of paper in a paper proceeding direction is referred to as a front edge and the other edge of the paper opposite to the front edge of the paper is referred to as a back edge, a distance between a back edge of the paper and a front edge of the following paper may be a paper sheet interval. When the paper sheet interval is greater than a predetermined interval, the controller **200** may control the transport speed of the following paper such that a predetermined paper sheet interval is maintained.

The controller **200** may acquire the transport speed of the following paper by using a change in the surface pattern of the following paper sensed by the second image sensor **120**. Based thereon, the controller **200** may control the feed rollers **420** such that a transport force corresponding to the transport speed of the following paper is transferred to the following paper. In this regard, the transport force corresponding to the transport speed of the following paper may indicate a force required to accelerate the following paper such that the predetermined paper sheet interval may be maintained between the paper and the following paper.

As illustrated in FIG. **5**B, when the feed rollers **420** rotate at a high speed and transfer a transport force corresponding to the transport speed of the following paper to the following paper, the following paper is transported at a high speed, thereby decreasing the paper sheet interval. As a result, the distance between the paper and the following paper may be maintained as a predetermined distance d.

FIGS. **6**A and **6**B are diagrams for describing a method of controlling a paper sheet interval by a controller of an image forming apparatus according to another embodiment of the present disclosure. Dashed lines indicate a paper transport path, and arrows indicate a paper transport direction.

FIG. **6**A illustrates that a paper passes between the registration rollers **410** and a following paper has already passed the feed rollers **420**.

A skew of paper may occur during a printing process of the image forming apparatus. In order to correct the skew of paper, the registration rollers **410** may block proceeding of

the paper. Since the feed rollers **420** transfers the transport force to the paper blocked by the registration rollers **410**, the skew of paper may be corrected.

In this regard, since the paper is transported while the registration rollers **410** block the proceeding of the following paper, the paper sheet interval may increase. Thus, the controller **200** may control the registration rollers **410** such that a predetermined paper sheet interval is maintained.

The controller **200** may acquire a transport speed of the paper by using a change in the surface pattern of the paper sensed by the first image sensor **110**. Based thereon, the controller **200** may control the registration rollers **410** to block the proceeding of the following paper at a time point corresponding to the transport speed of the paper. In this regard, the time point corresponding to the transport speed of the paper may indicate a time point when the paper has been discharged from the registration rollers **410** and transported by a predetermined distance.

As illustrated in FIG. **6**B, the controller **200** may stop driving of the registration rollers **410** at a time point when the paper has been discharged from the registration rollers **410** and transported by a predetermined distance k. Since the registration rollers **410** are stopped during the period of time determined by the controller **200**, the skew of the following paper may be corrected, and thus the distance between the paper and the following paper may be controlled.

Differently from FIGS. **6**A and **6**B, the controller **200** may control the paper feed unit **300** by using a transport speed of the paper. The controller **200** may control the paper feed unit **300** such that the following paper is fed at a time point corresponding to the transport speed of the paper. In this regard, the time point corresponding to the transport speed of the paper may be a time point for maintaining a predetermined paper sheet interval between the fed following paper and the paper being transported.

Alternatively, the controller **200** may control the feed rollers **420** by using the transport speed of the paper. The controller **200** may control the feed rollers **420** such that a transport force corresponding to the transport speed of the paper is transferred to the following paper. In this regard, the transport force corresponding to the transport speed of the paper may indicate a force required to accelerate the following paper such that a predetermined interval is maintained between the paper and the following paper.

The methods of controlling the paper sheet interval by using the change in the surface pattern of paper by the controller are described above. Methods of correcting a skew of paper by using a change in surface patterns of paper will be described with reference to FIGS. **7**A, **7**B, **8**A, **8**B, and **8**C.

FIGS. **7**A and **7**B are diagrams for describing a method of acquiring the degree of skew of paper by a controller **200** of an image forming apparatus according to another embodiment of the present disclosure. Dashed lines indicate regions including surface patterns sensed by the paper sensing unit **100**.

As described above, the paper sensing unit **100** may sense surface patterns of paper at regular time intervals. Since the paper sensing unit **100** may sense surface patterns of paper in real time, the controller **200** may acquire the degree of skew of paper.

For example, as illustrated in FIG. **7**A, the paper sensing unit **100** may sense a surface pattern of skewed paper in a region marked by the dashed line at a desired time point. After one period T, the paper sensing unit **100** may sense the surface pattern of the paper in the region marked by the dashed line as illustrated in FIG. **7**B. Referring to FIGS. **7**A and **7**B, it may be confirmed that the paper is transported by Δy in the proceeding direction and by Δx in a direction perpendicular to the proceeding direction.

The controller **200** may sense the degree of skew of paper by comparing the surface pattern of the paper sensed as illustrated in FIG. **7**A with the surface pattern of the paper as illustrated in FIG. **7**B. Particularly, the controller **200** may acquire a skew angle θ of the paper through Equation 2 and the degree of skew S of the paper by using the skew angle θ through Equation 3.

$$\sin\theta = \frac{\Delta x}{\Delta y} \quad \text{Equation 2}$$

$$S = \frac{w}{\sin\theta} \quad \text{Equation 3}$$

In these equations, θ is a skew angle of paper, Δy is a distance of paper moved in the paper proceeding direction, and Δx is a distance of the paper moved in the direction perpendicular to the proceeding direction of the paper. In addition, S is the degree of skew of the paper and w is a width of paper.

The controller **200** may acquire the degree of skew of paper and correct the skew of paper based thereon.

FIGS. **8**A to **8**C are diagrams for describing a method of controlling a skew of paper by a controller of an image forming apparatus according to the present disclosure, Arrows indicates a paper proceeding direction.

As illustrated in FIG. **8**A, a skew of paper may occur during a printing process of the image forming apparatus. In this case, the controller **200** may stop driving of the registration rollers **410**. Accordingly, the skew of paper to which the transport force is transferred by the feed rollers **420** may be corrected. In this case, the paper may be transported while transporting of the following paper is blocked by the registration rollers **410**, and thus the paper sheet interval may increase. Thus, the controller **200** needs to stop driving of the registration rollers **410** in consideration of the degree of skew of the following paper.

The controller **200** may acquire the degree of skew of the paper when the front edge of the paper reaches the registration rollers **410**. The controller **200** may correct the skew in consideration of the degree of skew when the front edge of the paper reaches the registration rollers **410**.

Thus, as illustrated in FIG. **8**B, the controller **200** may block the proceeding of the paper for a period of time corresponding to the degree of skew of paper. The period of time corresponding to the degree of skew of the paper may refer to a minimum period of time required for correcting the skew by blocking the proceeding of the paper by using the registration rollers **410**. In accordance with the degree of skew S obtained through Equation 3, the controller **200** may stop driving of the registration rollers **410** for a period of time corresponding to the degree of skew S.

After driving of the registration rollers **410** is stopped for a period of time corresponding to the degree of skew, the paper may be transported by resuming the driving of the registration rollers **410** when the skew of the paper is completely corrected as illustrated in FIG. **8**C. Thus, time required for the correction of the skew may be minimized resulting in increasing the paper sheet interval.

In addition, the controller **200** may control the image forming unit **500** to coat toner on the photosensitive drum **510** at a time point corresponding to when driving the registration rollers **410** is resumed. Since the paper is discharged from the

registration rollers **410** immediately before an image is formed, the image forming unit **500** may start preparation for formation of an image on the paper at a time point corresponding to when the registration rollers **410** are resumed. Thus, the time point corresponding to when the driving of the registration rollers **410** is resumed may indicate a time point of coating toner on the photosensitive drum **510** such that an image is formed on the paper discharged from the registration roller **410**, driving of which is resumed.

The controller **200** may acquire a transport speed of the paper based on a change in the surface pattern of the paper acquired by the paper sensing unit **100** and may determine a paper jam by using the same. That is, when the transport speed of the paper is equal to or less than a predetermined value or the paper is not sensed within a time corresponding to the acquired transport speed, the controller **200** may determine that a paper jam occurs in one area of the paper transport path in the image forming apparatus.

Upon determination that the paper jam occurs, the controller **200** may inform a user of the paper jam or may control the image forming apparatus to remove the paper jam in accordance with a preset paper jam-removing process.

FIG. **9** is a flowchart illustrating a method of controlling a paper sheet interval according to a method of controlling an image forming apparatus according to an embodiment of the present disclosure. FIG. **9** illustrates an example of a method of controlling the paper sheet interval by using a first image sensor **110**.

First, paper is transported by using the paper transport unit **400** (**600**). The paper receives a transport force from the feed rollers **420** and is transported to the image forming unit **500** via the registration rollers **410**.

A transport speed of the paper may be acquired by using a first image sensor **110** (**610**). Particularly, a surface pattern of the paper may be sensed by the first image sensor **110** when the paper passes between the registration rollers **410**. By using a change in the sensed surface pattern of the paper, the transport speed of the paper may be acquired.

A time point of feeding following paper may be determined in accordance with the acquired transport speed of the paper (**620**). The time point of feeding the following paper may be determined such that a predetermined distance may be maintained between the paper being transported and the following paper.

When the time point of feeding the following paper is determined, the paper feed unit **300** may be controlled to feed the following paper at the determined time point (**630**). As a result, a predetermined paper sheet interval may be maintained.

FIG. **10** is a flowchart illustrating a method of controlling a paper sheet interval according to a method of controlling an image forming apparatus according to another embodiment of the present disclosure. FIG. **10** illustrates another example of the method of controlling the paper sheet interval by using the first image sensor **110**.

First, paper is transported by using the paper transport unit **400** (**700**). The transport speed of the paper may be acquired by using the first image sensor **110** in the same manner described above with reference to FIG. **9** (**710**).

A time point of stopping the registration rollers **410** may be determined in accordance with the acquired transport speed of the paper (**720**). The time point of stopping the registration rollers **410** may be determined as a time point in which the paper has been discharged from the registration rollers **410** and transported by a predetermined distance.

When the time point of stopping is determined, the registration rollers **410** may be stopped at the determined time point (**730**). As the registration rollers **410** are stopped in a consideration of the transport speed of the paper, the time point of stopping the registration rollers **410** for the correction of the skew of the paper may be efficiently controlled.

FIG. **11** is a flowchart illustrating a method of controlling a paper sheet interval according to a method of controlling an image forming apparatus according to another embodiment of the present disclosure. FIG. **11** illustrates a method of controlling a paper sheet interval by using a second image sensor **120**.

First, following paper may be transported by using the paper transport unit **400** (**800**). Particularly, the following paper may be transported by transferring a transport force to the following paper by the feed rollers **420**.

While the following paper is transported, a transport speed of the following paper may be acquired by using the second image sensor **120** (**810**). Particularly, a surface pattern of the following paper may be sensed when the paper passes between the feed rollers **420** by the second image sensor **120**. The transport speed of the following paper may be acquired based on a change in the sensed surface pattern of the following paper.

When the transport speed of the following paper is acquired, a transport force corresponding to the transport speed of the following paper may be transferred to the following paper (**820**). The transport force corresponding to the transport speed of the following paper may indicate a force required to accelerate the following paper such that a predetermined interval may be maintained between the paper and the following paper.

In order to determine the transport force corresponding to the transport speed of the following paper, the transport speed of the following paper, the transport speed of the paper, or the distance between the registration rollers **410** and the feed rollers **420** may be used.

As the following paper is accelerated by transferring the transport force to the following paper, it may be confirmed whether a paper sheet interval between the paper and the following paper is equal to or less than d (**830**). The reference letter d refers to a predetermined paper sheet interval suitable for a printing process of the image forming apparatus.

When the paper sheet interval is greater than d, the paper sheet interval may be controlled to be equal to or less than d by continuously transferring the transport force to the following paper.

On the other hand, when the paper sheet interval is equal to or less than d, the control process may be terminated since conditions for printing are satisfied.

FIG. **12** is a flowchart illustrating a method of correcting a skew of paper according to a method of controlling an image forming apparatus according to another embodiment of the present disclosure. FIG. **12** illustrates a method of correcting a skew of paper by using a second image sensor **120**.

First, following paper may be transported by the paper transport unit **400** (**900**). The following paper may be transported by transferring a transport force to the following paper by the feed rollers **420** in the same manner described above with reference to FIG. **11**.

While the following paper is transported, it may be confirmed whether the front edge of the following paper reaches the registration rollers **410** (**910**). The front edge of the following paper may refer to a leading edge of the following paper in the paper transport direction.

Before the front edge of the following paper reaches the registration rollers **410**, it may be repeatedly confirmed whether the front edge of the following paper reaches the registration rollers **410**.

On the other hand, when the front edge of the following paper reaches the registration rollers **410**, the degree of skew of the following paper may be acquired by using the second image sensor **120** (**920**). The degree of skew of the following paper may be acquired through Equations 2 and 3 as described above.

When the degree of skew is acquired, the skew of the following paper may be corrected by stopping the registration rollers **410** for a period of time corresponding to the degree of skew (**930**). The period of time corresponding to the degree of skew may refer to a minimum period of time required for correcting the skew by blocking proceeding of the following paper by the registration rollers **410**.

As is apparent from the above description, according to the image forming apparatus and the control method thereof according to an embodiment of the present disclosure, the distance between paper sheets may be reduced by acquiring the transport speed of paper by sensing a surface pattern of paper in real time.

According to the image forming apparatus and the control method thereof according to another embodiment of the present disclosure, the skew of paper may be efficiently removed by acquiring the degree of skew of paper by sensing a surface pattern of paper in real time.

According to the image forming apparatus and the control method thereof according to another embodiment of the present disclosure, unnecessary consumption of toner may be prevented when an image is formed in an image trans belt (IBT) by sensing a paper jam in real time.

Although a few embodiments of the present disclosure have been shown and described, it would be appreciated by those skilled in the art that changes may be made in these embodiments without departing from the principles and spirit of the disclosure, the scope of which is defined in the claims and their equivalents.

What is claimed is:

**1**. An image forming apparatus comprising:

a paper transport unit configured to sequentially transport a plurality of sheets of paper;

a paper sensing unit disposed in a transport path of the plurality of sheets of paper and configured to sense a surface pattern of each of the transported plurality of sheets of paper; and

a controller configured to acquire a first transport speed of a first sheet of paper by using the change in the surface pattern of the first sheet of paper, acquire a second transport speed of a second sheet of paper following the first sheet of paper by using the change in the surface pattern of the second sheet of paper, and control the paper transport unit to maintain a predetermined distance between the first sheet of paper and the second sheet of paper based on the first transport speed and the second transport speed.

**2**. The image forming apparatus according to claim **1**, wherein the controller acquires a degree of skew of each of the plurality of sheets of paper by using the change in the surface pattern of each of the plurality of sheets of paper and controls the paper transport unit to correct the skew of each of the plurality of sheets of paper for a period of time based on the acquired degree of skew of each of the plurality of sheets of paper.

**3**. The image forming apparatus according to claim **1**, wherein the paper transport unit comprises:

feed rollers configured to transfer a transport force to each of the plurality of sheets of paper; and

registration rollers configured to block proceeding of each of the plurality of sheets of paper to which the transport force is transferred by the feed rollers, and

the paper sensing unit is disposed in the transport path of the plurality of sheets of paper between the feed rollers and the registration rollers.

**4**. The image forming apparatus according to claim **3**, wherein the paper sensing unit comprises a first image sensor disposed closer to the registration rollers than the feed rollers to sense the surface pattern of the first sheet of paper.

**5**. The image forming apparatus according to claim **4**, wherein the controller acquires the first transport speed by using the change in the surface pattern of the first sheet of paper sensed by the first image sensor and controls the registration rollers to block proceeding of the second sheet of paper at a time point based on the first transport speed and the second transport speed.

**6**. The image forming apparatus according to claim **4**, further comprising a paper feed unit configured to sequentially feed the first sheet of paper and the second sheet of paper to the paper transport unit,

wherein the controller acquires the first transport speed of the first sheet of paper by using the change in the surface pattern of the first sheet of paper sensed by the first image sensor and controls the paper feed unit to feed the second sheet of paper at a time point based on the first transport speed and the second transport speed.

**7**. The image forming apparatus according to claim **3**, wherein the paper sensing unit comprises a second image sensor disposed closer to the feed rollers than the registration rollers to sense a surface pattern of the second sheet of paper.

**8**. The image forming apparatus according to claim **7**, wherein the controller acquires the second transport speed by using the change in the surface pattern of the second sheet of paper sensed by the second image sensor and controls the feed rollers to transfer the transport force to the second sheet so as to adjust the second transport speed.

**9**. The image forming apparatus according to claim **7**, wherein the controller acquires the degree of skew of the second sheet of paper by using the change in the surface pattern of the second sheet of paper sensed by the second image sensor and controls the registration rollers to block proceeding of the second sheet of paper for a period of time based on the degree of skew of the second sheet of paper.

**10**. The image forming apparatus according to claim **9**, further comprising an image forming unit configured to transfer an image to each of the plurality of sheets of paper by using a photosensitive drum on which toner is coated,

wherein the controller controls the image forming unit to coat the toner on the photosensitive drum at a time point corresponding to when the registration rollers resume the proceeding of the second sheet of paper.

**11**. A method of controlling an image forming apparatus sequentially transporting a plurality of sheets of paper, the method comprising:

sensing a surface pattern of each of the plurality of sheets of paper;

acquiring a first transport speed of a first sheet of paper by using the change in the surface pattern of the first sheet of paper;

acquiring a second transport speed of a second sheet of paper following the first sheet of paper by using the change in the surface pattern of the second sheet of paper; and

maintaining a predetermined distance between the first sheet of paper and the second sheet of paper based on the first transport speed and the second transport speed.

12. The method according to claim 11, wherein maintaining the predetermined distance comprises blocking proceeding of the second sheet of paper at a time point based on the first transport speed and the second speed.

13. The method according to claim 11, wherein the maintaining the predetermined distance comprises feeding the second sheet of paper to a paper transport unit of the image forming apparatus at a time point based on the first transport speed and the second transport speed.

14. The method according to claim 11, wherein the maintaining the predetermined distance comprises transferring a transport force to the second sheet of paper based on the first transport speed and the second transport speed.

15. The method according to claim 11, further comprising:

acquiring a degree of skew of each of the plurality of sheets of paper by using the change in the surface pattern of each of the plurality of sheets of paper: and

correcting the skew of each of the plurality of sheets of paper for a period of time based on the acquired degree of skew.

16. The method according to claim 15, wherein the acquiring of the degree of each of skew of the plurality of sheets of paper comprises acquiring the degree of skew of each of the plurality of sheets of paper when a front edge of each of the plurality of sheets of paper reaches registration rollers of the image forming apparatus.

17. The method according to claim 15, wherein the correcting of the skew of each of the plurality of sheets of paper comprises blocking proceeding of each of the plurality of sheets of paper for a period of time based on the degree of skew of each of the plurality of sheets of paper.

18. The method according to claim 17, further comprising coating toner on a photosensitive drum of the image forming apparatus based on a time point when the blocked proceeding of each of the plurality of sheets of paper is resumed.

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